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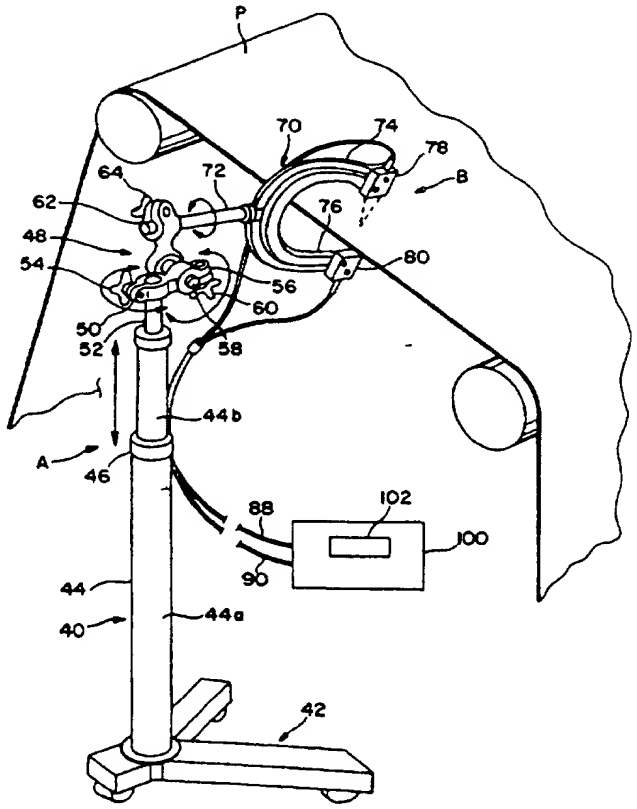
(54) Title: APPARATUS AND METHOD FOR MEASURING THE CALIPER OF PAPERMAKING FABRIC IN A NON-CONTACTING MANNER

(57) Abstract

An apparatus and method for measuring the caliper of papermaking fabric (P) in a non-contacting manner on a papermaking machine is disclosed wherein a displacement meter unit (B) supported on a stand (40) adjacent a run of the papermaking fabric (P) in such a manner that the pair of opposed displacement meters (78, 80), may be aligned perpendicular to the opposing fabric surfaces for measuring their displacement. First and second displacement signals (88, 90) are generated which are processed to, provide a caliper signal representing the thickness of the fabric (P) which can be used to indicate its condition for dewatering performance. A universal coupling (48) mounts the displacement meter unit (B) on the stand (40) so that the apparatus may be aligned for different inclinations of fabric runs.



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APPARATUS AND METHOD FOR MEASURING THE CALIPER OF PAPERMAKING FABRIC IN A NON-CONTACTING MANNER

Background of the Invention

This invention relates to papermaking machines, more particularly, to papermaking fabrics used on papermaking machines to support and transport paper pulp at various stages of the papermaking process, and in particular, to apparatus for measuring the thickness of the fabric to determine its performance value.

A typical papermaking machine includes many sections at which the wood pulp and sheet is processed at various stages, namely, the forming section, the press section, dryer section, and the paper roll take-up section. In the press section, water removal is the important function. A large amount of water must be removed from the paper sheet at the press section to realize good drying economy. Greater efficiency in water removal creates a drier sheet leaving the presses. The paper sheet entering the press section will have a dryness of about 18% to 25% solids; when it leaves the press section, the sheet should have about 36% to 44% solids. Among other things, press efficiency is determined by the condition of the press fabric, or felt as it is typically called, which supports the paper as it is pressed between press nips for water removal. An important condition of the fabric is the degree to which it has been compacted or compressed during operation in the press section. If the fabric is compacted too much, the fabric no longer has the resiliency, and also lacks the drainage capability to maintain a high level of pressing efficiency. Most press fabrics will ultimately compact so that drainage is retarded and pressing becomes inefficient.

The degree of compaction of the press fabric is typically determined and checked by using a fabric caliper measurement. Typically, hand-held instruments are utilized which are mounted on a C-frame which holds the anvils contacting the fabric, and a dial indicator which shows the fabric thickness. These instruments are much like a typical micrometer measurements. However, not only is the hand-held measurement

susceptible to errors and unreliability, but it is necessary that such physical contact is had with the fabric which can damage the fabric and/or operators. This is particularly true where measurements are attempted while the fabric is traveling at high speeds during operation.

Accordingly, an important object of the present invention is to provide an apparatus for measuring the caliper of a papermaking fabric without contacting the fabric, in a simple and reliable manner.

Another object of the present invention is to provide an apparatus for measuring the caliper of a papermaking fabric on a papermaking machine which eliminates the need for the apparatus to be held by hand eliminating the unreliability of hand-held measurements.

Another object of the invention is to provide an apparatus which can be utilized to measure the caliper of a papermaking fabric on different angular runs of the fabric on the papermaking machine.

Summary of the Invention

The above objectives are accomplished according to the invention by providing an apparatus and method for measuring the caliper of papermaking fabric without contacting the fabric. The apparatus includes a stand and an outwardly extending support carried by the stand on which a pair of displacement meters are carried in a spaced apart manner for receiving the papermaking fabric between the displacement meters. The first displacement meter is disposed on the outwardly extending support so that the first displacement meter generates a first displacement signal corresponding to a distance from the first displacement meter to a first surface of the papermaking fabric. The second displacement meter is disposed on the outwardly extending support so that the second displacement meter generates a second displacement signal corresponding to a distance from the second displacement meter to a second surface of the papermaking fabric. An electronic processor receives the first and second displacement signals and transforms the first and second displacement signals into a caliper signal representing the

thickness of the fabric. The stand includes an adjustable universal coupling for connecting the outwardly extending support to the stand so that the position of the displacement meters may be adjusted in any direction so that proper orientation of the displacement meters may be had in relation to the papermaking fabric for accurate and reliable measurements. Preferably, the adjustable universal coupling includes an adjustable yaw coupling, an adjustable pitch coupling, and an adjustable roll coupling. The stand comprises a base which is supported on the floor, and an upright support carried by the base, the universal coupling being carried by the upstanding support. The upstanding support includes a telescoping standard for vertically adjusting the position of the outwardly extending support and displacement meters. The outwardly extending support includes a fork having first and second spaced apart legs. The first displacement meter is carried by the first leg, and the second displacement meter is carried by the second leg. The first and second displacement meters are spaced apart by a fixed distance as the papermaking fabric travels between the displacement meters for measurement of the caliper. A first guide bar is carried by the first leg terminating in a first fabric engaging end. A second guide bar is carried by the second leg terminating in a second fabric engaging end. The first and second fabric engaging ends of the first and second guide bars constrain the fabric therebetween and define a measurement range in which the displacement measurements of the first and second displacement meters are effective.

Preferably, the first and second displacement meters are laser displacement meters. The first laser displacement meter emits a first laser beam which impinges upon a first surface of the fabric and is used to generate the first displacement signal corresponding to the distance from the first laser displacement meter to the first surface of the papermaking fabric. The second laser displacement meter emits a second laser beam which impinges upon a second surface of the fabric and is used to generate a second displacement signal corresponding to the distance from the first laser displacement meter to the first surface of the papermaking fabric.

A method of measuring the caliper of papermaking fabric mounted on a papermaking machine in a non-contacting manner includes mounting a first displacement meter on a first side of the papermaking fabric and mounting a second displacement meter on a second side of the papermaking fabric. Next, the displacement of the first and second displacement meters from the first and second sides of the papermaking fabric is measured. Finally, the caliper of the papermaking fabric, based on the first and second displacement signals, is calculated. The first and second displacement meters are mounted stationarily on a stand so that the first and second displacement meters are spaced a fixed distance and the papermaking fabric travels between the first and second displacement meters. The movement of the fabric toward and away from the first and second displacement meters is limited so that the fabric travels between the first and second displacement meters in a preset measurement range effective for measuring caliper. The first and second displacement meters are affixed to the stand using a universal coupling so that the first and second displacement meters may be turned and adjusted in any direction.

Description of the Drawings

The construction designed to carry out the invention will hereinafter be described, together with other features thereof.

The invention will be more readily understood from a reading of the following specification and by reference to the accompanying drawings forming a part thereof, where in an example of the invention is shown and wherein:

Figure 1 is a schematic side elevation illustrating an apparatus for measuring the caliper of papermaking fabric on a papermaking machine wherein the apparatus is illustrated as being applied to the press section of a papermaking machine;

Figure 2 is an enlarged perspective view of an apparatus for measuring the caliper of papermaking fabric on a papermaking machine according to the invention; and

Figure 3 is an elevation illustrating apparatus constructed according to the present invention for measuring the

caliper of papermaking fabric on a papermaking machine in a non-compacting manner.

Description of a Preferred Embodiment

Referring now in more detail to the drawings, an apparatus and method for measuring the caliper of papermaking fabric on a papermaking machine will now be described in more detail. Since papermaking machines and their various sections are well known to those skilled in the art, as well as the papermaking fabrics which run on papermaking machines, only so much of a papermaking machine and fabric as is necessary to an understanding of the invention will be disclosed. While the invention may have application to the papermaking fabrics utilized in the different sections of a papermaking machine, i.e. forming section, press section, dryer section, for measuring thickness and hence wear, it is most advantageous in a press section. Accordingly, Figure 1 is an illustration of a press section of a papermaking machine in schematic form.

The illustrated embodiment of a press section in Figure 1 is that of a 3-roll incline press which includes a first, second, and third press fabrics 10, 12, 14. The press fabrics are mounted about rollers to form endless felts. As illustrated, the different press fabrics, or felts as they are typically called, form a first press at 16, a second press at 18, and a third press at 20 for water removal. As the paper sheet is transported through the nip of the first, second and third presses, water is squeezed out of the paper as the paper sheet is sandwiched between the pressed fabric and the roll. A center roll 22 is included in the first and second presses 16, 18; and a top roll 24 is included in the third press. The first press includes center roll 22 and a first press roll 26. The second press includes center roll 22 and a second press roll 28. Third press 20 includes top roll 24 and a third press roll 30. In the first press, the paper sheet is pressed between center roll 22 and press fabric 10. In the second press, the paper sheet is pressed between center roll 22 and press fabric 12. In the third press, paper sheet is pressed between top roll 24 and press fabric 14 as supported by third press roll 30.

Referring now in more detail to the invention, an apparatus for measuring the caliper of the various press fabrics mounted on the papermaking machine at the press section, it is designated generally as A. Apparatus A includes a stand 40 which includes a base 42 and an upright support 44. Base 42 may be any suitable type of a pedestal base such as the tri-leg base having rollers, as illustrated. Upright support 44 is preferably in the form of a telescoping standard including a first standard 44a and a second standard 44b which is telescopically received in first standard 44a. A suitable standard cam lock 46 may be provided for locking standard 44b at a desired vertical position relative to lower standard 44a. An adjustable, universal coupling, designated generally as 48 includes a yaw coupling 50 connected to a standard shaft 52 affixed to upper standard 44b. A turn screw having a manual knob 54 locks and unlocks yaw coupling 50 to adjust it about standard shaft 52. A pitch coupling 56 is provided by a pitch shaft 58 affixed within the pitch coupling. A turn screw having a handle 60 is provided for adjusting the pitch coupling. Pitch shaft 58 is affixed to a roll coupling 62 having a turn screw with a handle 64.

An outwardly extending support in the form of a fork, designated generally as 70 is affixed to the universal coupling by means of a fork shaft 72 affixed within roll coupling 62. In this manner, fork shaft 72 may be moved in any direction, the purposes of which will be explained more fully. Fork 70 includes a first leg 74 and a second leg 76 which are spaced apart. A laser displacement measurement assembly, designated generally as B, includes a first displacement meter 78 is carried on first leg 74, and a second displacement meter 80 is carried on second leg 76. Preferably, first and second displacement meters 78, 80 are laser displacement meters which emit a first laser beam 82 and a second laser beam 84. Press fabric 10 travels between first and second displacement meters 78, 80 for caliper measurement, as can best be seen in Figures 2, 3. Suitable laser displacement meters are available from the Keyence Corporation of America, Fairlawn, New Jersey, Model No. LC-2320 having general application to displacement and thickness measuring.

As can best be seen in Figure 3, first laser displacement meter 78 is affixed to first leg 74 and second laser displacement 80 is affixed to second leg 76 with the distance between the emitting and receiving faces 82a, 80a of the displacement meters being a fixed distance indicated by "d". First laser beam 82 impinges upon a first surface or side 86a of press fabric P. Second laser beam 84 impinges upon a second side or surface 86b of press fabric P. First and second laser beams 82, 84 are representative of and are used to generate first and second displacement signals 88, 80, respectively, which correspond to the displacement of the first and second sides of the fabric from the displacement meters.

There is only a certain length of laser beams 82, 84 which is effective for measuring the displacement of the size of the press fabric. For this purpose, the travel of press fabric P must be constrained within this range for effective and reliable measurement of displacement signals. For this purpose, guide bars 92, 94 are carried on first and second legs 74, 76, respectively. Guide bars 92, 94 have respective fabric engaging free ends 92a, 94a which engage the fabric and limit its path of travel so as to maintain the fabric within the effective measurement range "X". In one example of the illustrated embodiment, the fixed distance "d" between the faces of the displacement meters is four inches, and the effective measurement range "X" defined by the fabric engaging ends of the guide bars is equal to one inch. This requires that the guide bars terminate at approximately one and one-half inches past the faces of the displacement meters.

First and second displacement meters 78, 80 generate first and second displacement signals 88, 90 respectively, which are received by a conventional electronic processor 100 which transforms the displacement signals into a caliper signal representing the thickness of the fabric. The caliper signal may be displayed on a display 102 or may be transmitted to a recorder or computer for further processing. The universal coupling 48 provides that the faces 78a, 80a of the displacement meters are oriented perpendicularly to the press fabric P as it travels

between the displacement meters so that reliable measurements can be had. In this manner, fork 70 and laser displacement units may be turned in any direction so as to align the displacement meters properly on any of the inclined runs of the press fabric. A reliable caliper signal indicating the thickness of the press fabric may be had according to the invention without contacting the press fabric. The caliper measurements may be displayed or recorded for further processing and used in any manner to evaluate the performance condition of the press fabric so that it can be determined whether replacement is necessary, as well as for other reasons.

While, in the illustrated embodiment, displacement measurement assembly B is mounted on a stand, the measurement assembly may, in some applications, also be carefully held by hand during use. While a stand is illustrated, it is to be understood that measurement assembly B (and fork 70) may be supported by any associated structure whether stationary or mobile, e.g. a fork lift truck, as long as a stable support is provided.

While a preferred embodiment of the invention has been described using specific terms, such description is for illustrative purposes only, and it is to be understood that changes and variations may be made without departing from the spirit or scope of the following claims.

What is claimed is:

1. An apparatus for measuring the caliper of papermaking fabric without contacting said fabric, said papermaking fabric being mounted in an endless manners about a plurality of rollers on a papermaking machine, said apparatus comprising:

a displacement measurement assembly including first and second displacement meters carried in a spaced apart manner for receiving said papermaking fabric between said displacement meters;

said first displacement meter being disposed so that said first displacement meter generates a first displacement signal corresponding to a distance from said first displacement meter to a first surface of said papermaking fabric;

said second displacement meter being disposed so that said second displacement meter generates a second displacement signal corresponding to a distance from said second displacement meter to a second surface of said papermaking fabric; and

an electronic processor receiving said first and second displacement signals for transforming said first and second displacement signals into a caliper signal representing the thickness of said fabric.

2. The apparatus of claim 1 including a stand, an outwardly extending support carried by said stand on which said displacement measurement assembly is carried; and wherein said stand includes an adjustable universal coupling for connecting said outwardly extending support to said stand for adjusting the position of said displacement meters in any direction so that proper orientation of said displacement meters may be had in relation to said papermaking fabric for accurate measurements.

3. The apparatus of claim 2 where in said adjustable universal coupling includes an adjustable yaw coupling, an adjustable pitch coupling, and an adjustable roll coupling.

4. The apparatus of claim where in said stand comprises a base which is supported on the floor, and an upright

support carried by said base, said universal coupling being carried by said upstanding support.

5. The apparatus of claim 4 wherein said upstanding support comprises a telescoping standard for vertically adjusting the position of said outwardly extending support and displacement meters.

6. The apparatus of claim 1 including a stand, an outwardly extending support carried by said stand on which said displacement measurement assembly is carried; and wherein said outwardly extending support includes a fork having first and second spaced apart legs carried by said stand, said first displacement meter being carried by said first leg, and said second displacement meter being carried by said second leg so that said first and second displacement meters are spaced apart by a fixed distance as said papermaking fabric travels between said displacement meters for measurement of said caliper.

7. The apparatus of claim 6 including a first guide bar carried by said first leg terminating in a first fabric engaging end, a second guide bar carried by said second leg terminating in a second fabric engaging end, and said first and second fabric engaging ends of said first and second guide bars constraining said fabric therebetween and defining a measurement range in which said displacement measurements of said first and second displacement meters are effective.

8. An apparatus for measuring the caliper of papermaking fabric without contacting said fabric, said papermaking fabric being mounted in an endless manner about a plurality of rollers on a papermaking machine, said apparatus comprising:

a stand;

a support carried by said stand;

a first laser displacement meter and a second laser displacement meter carried by said support in a spaced apart manner for receiving said papermaking fabric between said laser displacement meters;

a fixed distance defined between said first and second laser displacement meters as carried by said support;

said first laser displacement meter emitting a first laser beam which impinges upon a first surface of said fabric and is used to generate a first displacement signal corresponding to the distance from said first laser displacement meter to said first surface of said papermaking fabric;

said second laser displacement meter emitting a second laser beam which impinges upon a second surface of said fabric and is used to generate a second displacement signal corresponding to the distance from said first laser displacement meter to said first surface of said papermaking fabric;

an electronic processor receiving said first and second displacement signals for transforming said first and second displacement signals into a caliper signal representing the thickness of said fabric.

9. The apparatus of claim 8 wherein said first laser beam has a first effective length in which said first displacement signal is reliable and said second laser beam has a second effective length in which said second displacement signal is reliable, and said apparatus includes guide bars carried by said support for constraining a travel path of said papermaking fabric within said effective lengths of said first and second laser beam signals.

10. The apparatus of claim wherein said stand includes an adjustable universal coupling for connecting said outwardly extending support to said stand for adjusting the position of said displacement meters in any direction so that proper orientation of said displacement meters may be had in relation to said papermaking fabric for accurate measurements.

11. The apparatus of claim 10 wherein said adjustable universal coupling includes an adjustable yaw coupling, an adjustable pitch coupling, and an adjustable roll coupling.

12. The apparatus of claim 10 wherein said stand comprises a base which is supported on the floor, and an upright support carried by said base, said universal coupling being carried by said upstanding support.

13. The apparatus of claim 12 wherein said upstanding support comprises a telescoping standard for vertically adjusting

the position of said outwardly extending support and displacement meters.

14. The apparatus of claim 8 wherein said outwardly extending support includes a fork having first and second spaced apart legs carried by said stand, said first displacement meter being carried by said first leg, and said second displacement meter being carried by said second leg so that said first and second displacement meters are spaced apart by a fixed distance as said papermaking fabric travels between said displacement meters for measurement of said caliper.

15. The apparatus of claim 14 including a first guide bar carried by said first leg terminating in a fabric engaging end, a second guide bar carried by said second leg having a second fabric engaging end, and said first and second fabric engaging ends of said first and second guide bars constraining said fabric therebetween and defining a measurement range in which said displacement measurements of said first and second displacement meters are effective.

16. A method of measuring the caliper of papermaking fabric mounted on a papermaking machine in a non-contacting manner comprising:

mounting a first displacement meter on a first side of said papermaking fabric;

mounting a second displacement meter on a second side of said papermaking fabric;

measuring the displacement of said first and second displacement meters from said first and second sides of said papermaking fabric; and

calculating the caliper of said papermaking fabric based on said first and second displacement signals.

17. The method of claim 16 including mounting said first and second displacement meters stationarily on a stand so that said first and second displacement meters are spaced a fixed distance and said papermaking fabric travels between said first and second displacement meters.

18. The method of claim 17 including constraining movement of said fabric toward and away from said first and

second displacement meters so that said fabric travels between said first and second displacement meters in a preset measurement range effective for measuring caliper.

19. The method of claim 17 including affixing said first and second displacement meters to said stand using a universal coupling so that said first and second displacement meters may be turned and adjusted in any direction.

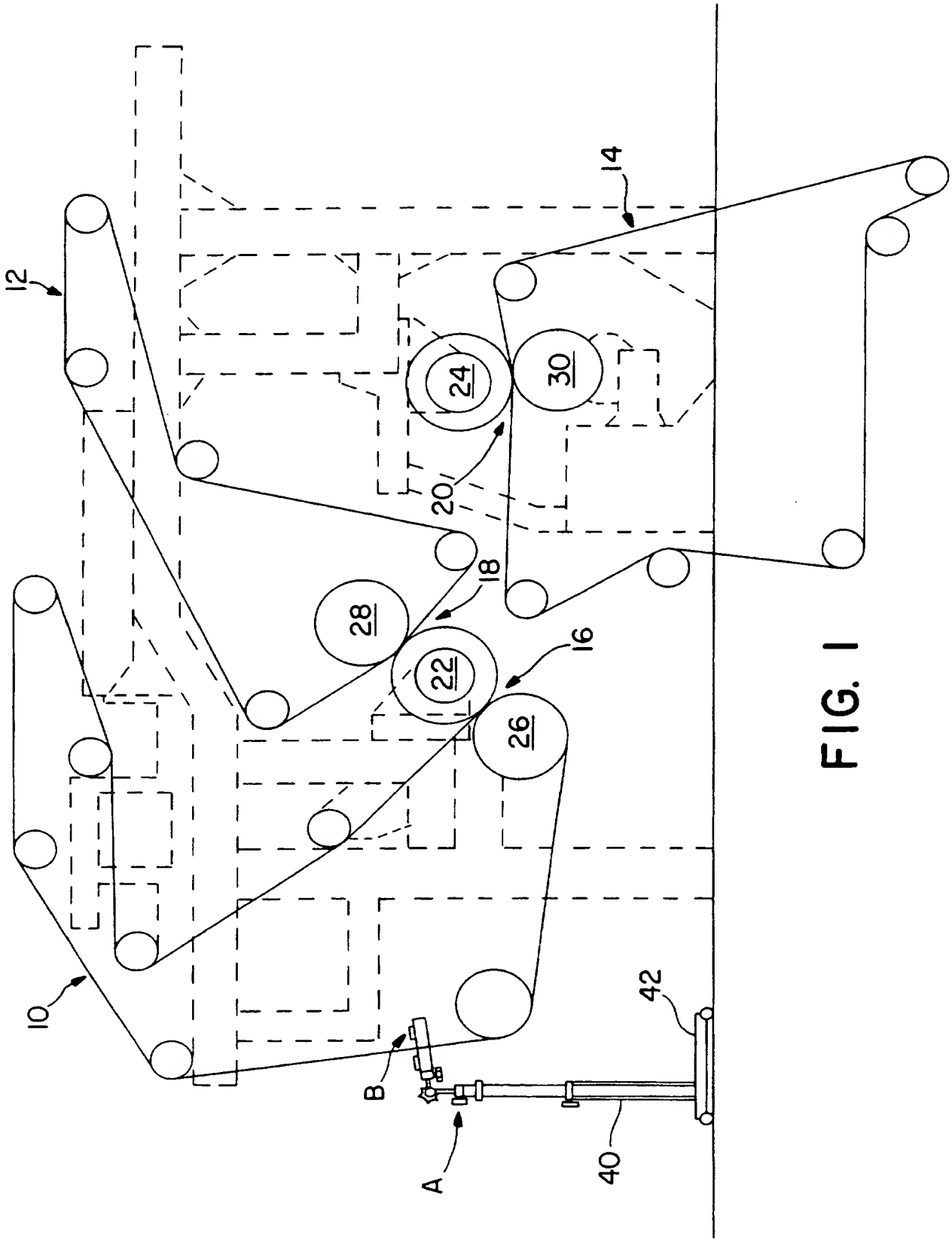

FIG. 1

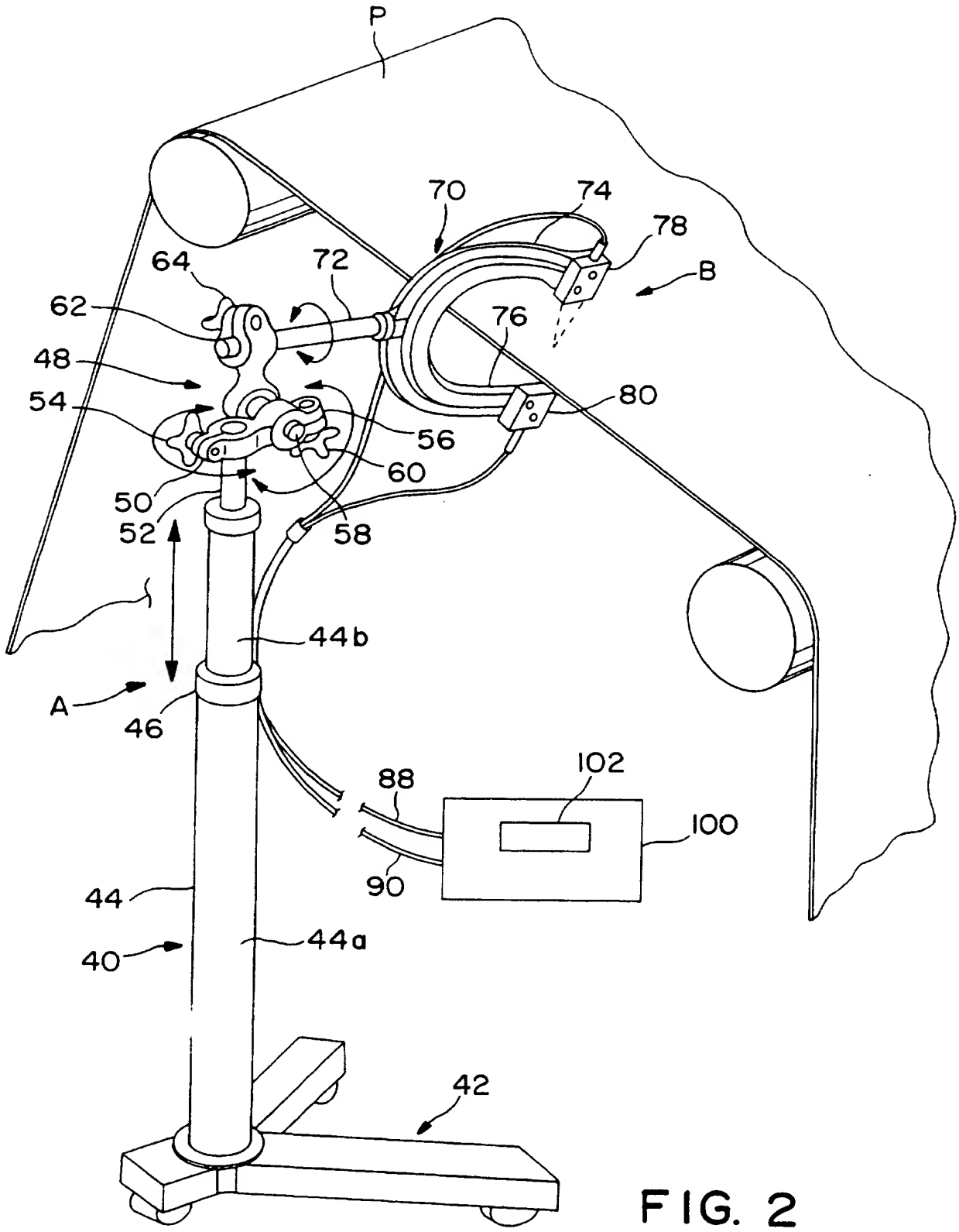

FIG. 2

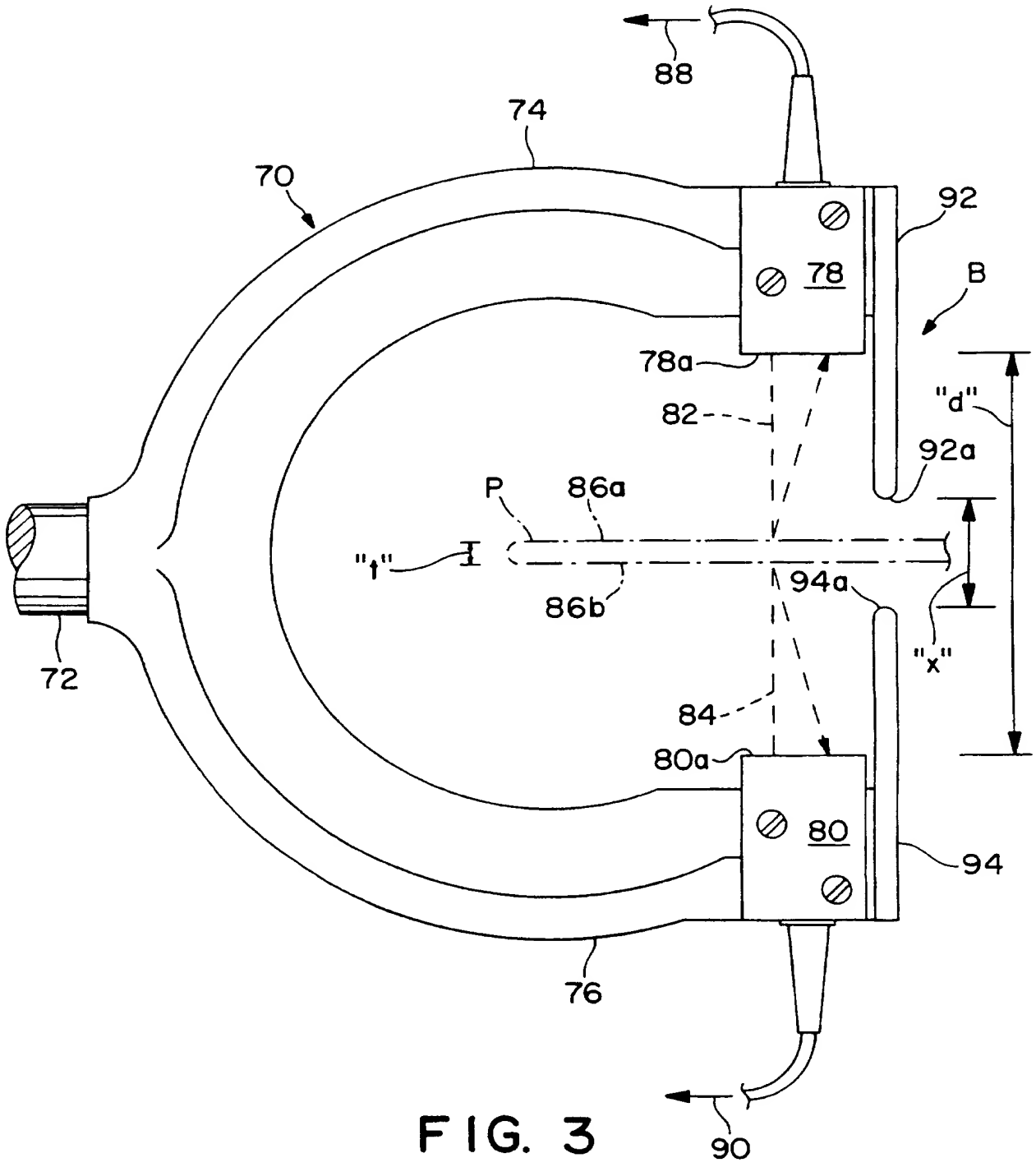

FIG. 3

INTERNATIONAL [redacted] REPORT

Int[redacted]plication No
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A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :G01B 11/02, 11/06, 11/14; D21F 7/06
US CL : 162/198, 263, 252, 262; 356/375, 381
According to International Patent Classification (IPC) or to both national classification and IPC

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U.S. : Please See Extra Sheet.

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

APS & DIALOG
Laser#, displace? meter#, fabric#, paper#, papier#, thickness, measu?

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US, A, 4,047,029 (ALLPORT) 06 SEPTEMBER 1977, SEE ENTIRE DOCUMENT.	1-19
Y	US, A, 4,375,921 (MORANDER) 08 March 1983, col. 3, lines 38-68 and col. 4, lines 31.	1-19
A	US, A, 3,565,531 (KANE ET AL.) 23 February 1971, SEE ENTIRE DOCUMENT	1, 6-10, 14 & 7-19
A	US, A, 4,068,955 (BODLAJ) 17 January 1978, SEE ENTIRE DOCUMENT.	1-19

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231 Facsimile No. (703) 305-3230	Authorized officer JOSE A. FORTUNA Telephone No. (703) 305-7498

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Minimum documentation searched
Classification System: U.S.

162/198, 263, 252, 262; 356/375, 381; 378/54, 55, 56; 33/517, 542, Dig 21